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ABSTRACT

Using the split-span technique in which auditory stimuli are presented in various combinations to the right and left ears, two studies were designed to examine the preferences of subjects as to their mode of recall, to assess the accuracy of such recall, and to look at possible sex differences in both the preferences and the accuracy. A total of 112 college students participated in the experiments. The materials used as stimuli were the digits zero through nine and ten consonants selected to provide minimal auditory confusions. Each trial consisted of six items in three pairs, with one member going to one ear only and the other member going only to the opposite ear. In the absence of instructions to recall in one way or another, subjects overwhelmingly preferred to recall ear by ear (i.e., all items from one ear followed by those from the other ear), even when the materials were presented so as to permit different modes of responding. Males and females behaved almost identically, with females tending to show a slight edge in accuracy in one experiment. The presentation of the stimuli in blocked sequences seemed to have no effect on recall. Digits were recalled significantly more accurately than consonants. Accuracy tended to be greater in the right ear under blocked conditions but not under unblocked conditions. (RL)

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Mode of Processing using the Split-Span Technique in Dichotic Listening

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INTRODUCTION

There were three major purposes to this study: (1) to examine the preferences of subjects as to their mode of recall; (2) to assess the accuracy of such recall; and (3) to look at possible sex differences in both the preferences and the accuracy.

In an early study, Broadbent (1954) concluded that we can process only one channel at a time. He used the split-span technique to present pairs of digits. His results showed that subjects recalled the stimulus materials ear by ear, completely recalling all the materials for one ear before those to the other ear. Gray and Wedderburn (1960) challenged Broadbent's theoretical conclusions by presenting different materials to each ear. They presented digits paired either with syllables of words or with words in a three-word phrase. Table 2 gives an example of each.

Table 2. Examples of materials, after Gray and Wedderburn (1960).

(1) Left ear	Right ear	(2) Left ear	Right ear
4	mas-	who	5
ter-	9	3	goes
7	ful	there	9

Their results showed that in about 50% of the trials, subjects reported as a unit the complete word, such as "masterful" or the complete phrase, such as "who goes there." Thus, the recall could be accomplished by meaning rather than by ear of arrival, when these two possibilities were in opposition to each other.

In almost all of the studies reported since Broadbent's original one, subjects have been instructed to report in one way or another. In those cases where such instructions are not given, the materials have not been such as to permit organization by content. Thus, Gray and Wedderburn's subjects (1960) were instructed to look for the complete word or phrase, and they showed that recall could be organized by a semantic channel. Moray (1960) instructed his subjects to recall "in any order they liked (free recall), or all the digits from one ear followed by all those from the other (successive recall), or by switching from ear to ear (alternate recall)."(p.214) However, the free recall conditions were always given first, for practice, and, since his materials con-

sisted only of digits presented as three pairs, there was no competing organization from the materials as in the Gray and Wedderburn study.

Broadbent and Gregory (1964) replicated Gray and Wedderburn using digits and phrases, or pairs of phrases, or digits and letters, but always with required modes of recall. Yntema and Trask (1963) used digit-word pairs, with required modes of recall. Bartz, et al, (1967) used digit-word pairs and did include free recall as one of its conditions. Savin (1967) had free recall, but with only pairs of digits used, subjects had no "semantic channel" to use. In one study, Sanders and Schroots (1968a) used digits and consonants as more comparable sets of stimuli, but they did not use dichotic listening; in a second study (1968b) using dichotic listening, they specified the mode of recall.

It seems important to investigate the preferred mode of recall and the accuracy of recall using pairs of items which are different, such as digits and letters, but which are not differentially organizable according to semantic content. That is, if three digits are presented sequentially to one ear, with the digits always being selected randomly, then the materials presented to the other ear ought to be no more and no less organizable than the digits. Three syllable words or three word phrases do have an inherent organization, so would three letters if vowels were employed. However, three consonants selected randomly from a set of 10 chosen for their low level of confusability (Conrad, 1964) would have no advantage over three digits. Thus, if subjects are instructed to recall the six items freely, rather than instructed to recall sequentially by ear, or by category, or by pairs, it should be possible to examine the preferences of subjects as to mode of recall.

METHOD

Design Two studies were performed, both being mixed factorial designs. (See Table 1) In Experiment 1, all subjects received 16 trials in each of the three conditions, with complete counterbalancing of conditions. An equal number of males and females were assigned randomly to the six permutations and to a balancing of materials between left and right ears.

In Experiment 2, subjects heard both digits and consonants on all trials. Trials were classified according to the number of transitions which took place during the trial, which consisted of three pairs of items. A transition is defined as changing from a digit to a consonant while remaining with the same ear, or changing ears while remaining with the same kind of item. An equal number of males and females were assigned randomly to one of two types of presentations, blocked or unblocked. In blocked trials, all 16 trials in a condition were presented together, followed by all the trials in the next condition, and so on. The order of transitions followed a standard Latin Square. For unblocked trials, the 4 types of transitions were randomly sequenced in four sets of 16 trials each. Again, materials were balanced across the ears.

Apparatus All sessions were conducted in one room, designed for perceptual research. Taped presentations of materials was by means of a Sony TC-260 stereo recorder and playback unit, using Koss Pro-4 headphones connected in parallel.

Subjects All subjects were volunteers from introductory psychology courses at Lafayette College in the Spring of 1980. Experiment 1 used 48 subjects, 24 males and 24 females. Experiment 2 used 64 subjects, 32 males and 32 females.

Stimulus Materials The materials used as stimuli were the 10 digits, 0 through 9, and 10 consonants selected to provide minimal auditory confusion (Conrad, 1964). Each trial consisted of 6 items, in 3 pairs, with one member going to one ear only, the other member going only to the opposite ear.

All materials were recorded by the author, using timing devices to present and

synchronize the materials at the rate of one pair each half second, with 13½ seconds between trials. Items were selected according to a modified random program without replacement, so that there was never any duplication of items within a trial, and all items were used equally often.

Instructions to subjects were also taped and presented along with a printed copy to follow. There were five practice trials for each experiment. Protocol sheets were provided and subjects were asked to listen to the entire set of 6 items, and then to write down as many items as they could remember in the order in which they were recalled. Each trial was preceded by a soft 500Hz tone as a ready signal. There was a constant rest period between conditions while tapes were set.

Scoring Protocols were scored as follows: (1) for each trial, the number of items, out of 6, which were recalled correctly was recorded, irrespective of where they appeared on the line; (2) a decision was made whether the recall was according to ear, to type of material, by pairs, or mixed; (3) which ear was represented first in recall; and (4) which kind of item was represented first in recall.

RESULTS

Mode of Response

Experiment 1. The mode of response was overwhelmingly by ear, with all other modes so infrequent in occurrence that they were combined into the single category, mixed. Figure 1 shows the mean trials (out of 16) for ear by ear versus mixed modes, for each condition. The difference between modes of recall is highly significant; none of the differencs among conditions is significant. When given free recall instructions, subjects show a strong preference for reporting all items from one ear followed by those from the other ear, and this preference holds for trials in which both ears receive the same kind of materials or in which one ear received one kind of material and the other ear a different kind of material. Figure 2 shows that males and females are essentailly the same in this preference.

Experiment 2. The results from Experiment 2 replicate those from Experiment 1. Figure 3 shows the same strong preference for ear by ear reporting, with no differences between males and females and none between blocked and unblocked trials. Figure 4 shows mode of response as a function of the number of transitions; notice that there is a significant difference between 0 transitions and both the 1B and 2 transition conditions, with 1A transitions intermediate, but that blocked versus unblocked shows no effect. Figure 5 shows the robustness of the preference for ear by ear recall: Condition CD in Experiment 1 is exactly replicated by the 0 transition, blocked trials in Experiment 2, using different subjects and different stimulus materials.

Accuracy Figure 6 shows that when digits are present, accuracy is greater than when only consonants are present, in Experiment 1. (There was no preference shown for reporting digits or consonants first.) Both the DD and the CD conditions yielded greater accuracy than the CC condition. Females tended to be more accurate than males ($F = 3.88$, $df = 1,46$; $p = .055$) but there was no interaction between sex and conditions. Figure 7 shows accuracy as a function of conditions and right versus left ear. There are no differences between ears in the accuracy of recall, contrary to most reports in the literature.(See, e.g., Bartz, et al., 1967) Figure 8 combines all conditions, showing that digits are more accurately recalled than consonants.

In Experiment 2, Figure 9 shows accuracy as a function of sex, type of material, and whether or not trials were blocked or unblocked. Only the main effect for digits versus consonants is significant; no other main effect and no interaction is significant. Figure 10 shows the first discrepancy with Experiment 1: for blocked trials, accuracy was greater for items presented to the right ear than to the left ear. Figure 11 shows no differences in accuracy for males versus females, or for blocked versus unblocked. Figure 12 shows that for both blocked and unblocked trials, 0 transitions resulted in greater accuracy; none of the other comparisons is significant. Figure 13 indicates the same superiority for digits over consonants as in Experiment 1.

Figures 14 and 15 contrast Condition CD, Experiment 1 with 0 transitions, blocked trials in Experiment 2. In figure 14, there is a significant main effect for type of item, and for Experiment 1 versus Experiment 2, and the interaction is significant. In Figure 15, both main effects and the interaction effect are significant. I have no ready explanation for the interaction effect: accuracy was essentially equal between the ears in Experiment 1, but in Experiment 2, the right ear showed the more usual superiority in accuracy over the left ear.

Conclusions In the absence of instructions to recall in one way or another, subjects overwhelmingly preferred to recall ear by ear, even when the materials were presented so as to permit different modes of responding. Males and females behaved almost identically, with females tending to show a slight edge in accuracy in one study. The first item reported was equally often a digit or a consonant, and equally often the first item reported had been presented to the right or the left ear. Blocking, in the second study, was essentially the same as not blocking, both in terms of mode of responding and in accuracy. With respect to accuracy, digits were recalled significantly more accurately than consonants. The only effect of blocking showed in an interaction between blocked versus unblocked and ears: accuracy tended to be greater in the right ear under blocked conditions, but not under unblocked conditions.

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HANDOUT to accompany

Paper presented at the Annual Convention of the Southeastern Psychological Association, New Orleans, March 26, 1982.

Table 1. Designs for Experiment 1 (N = 24M and 24F) and Experiment 2 (N= 32M and 32F)

Experiment 1			Experiment 2					
Condition	Left ear	Right ear	Condition (# transitions)	Left ear	Right ear		Left ear	Right ear
I	D	D		D	C		C	D
digits only	D	D	0	D	C	or	C	D
	D	D		D	C		C	D
	C	C		D	C		C	D
II	C	C	1A	C	D	or	D	C
consonants only	C	C		C	D		D	C
III	D	C		D	C		C	D
mixed digits and	D	C	1B	D	C	or	C	D
consonants	D	C		C	D		D	C
	or							
	C	D		D	C		C	D
	C	D	2	C	D	or	D	C
	C	D		D	C		C	D

Experiment 1: all subjects received 16 blocked trials in each of the three conditions; conditions were fully counterbalanced.

Experiment 2: all subjects received 16 trials in each of the four conditions; half the subjects received blocked trials, with conditions partially counterbalanced using a Latin Square; half the subjects received unblocked trials with conditions randomly sequenced with each of 4 sets of 16 trials.

D = digit, C = consonant; 0, 1A, 1B, 2 = number of transitions within a set of 3 pairs of items. Note that 1A and 1B each has only one transition but that the pattern differs. Note also that Condition 0, blocked, in Experiment 2 replicates Condition III in Experiment 1.

Table 2. Examples of materials, after Gray and Wedderburn (1960).

(1) Left ear	Right ear	(2) Left ear	Right ear
4	mas-	who	5
ter-	9	3	goes
7	ful	there	9

Gray, J.A. & Wedderburn, A.A.I. Grouping strategies with simultaneous stimuli. Quarterly Journal of Experimental Psychology, 1960, 12, 180-189.

Figure 1. Mode of response, by conditions, Experiment 1.

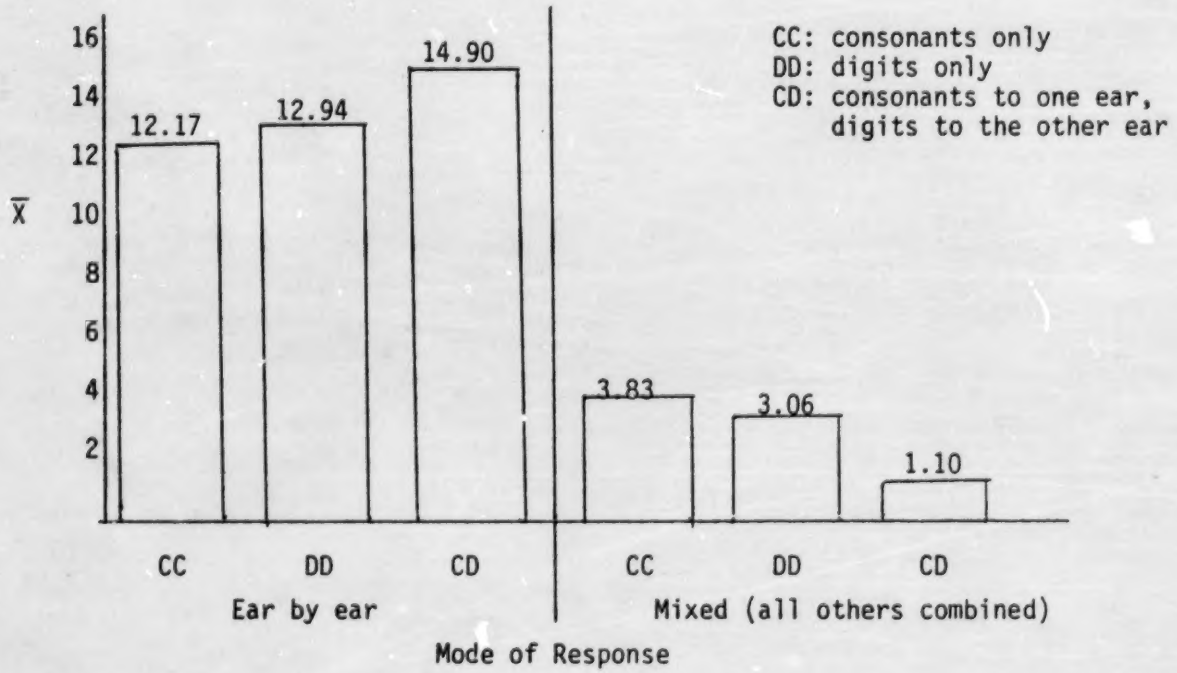

Figure 2. Mode of response, by sex, Experiment 1.

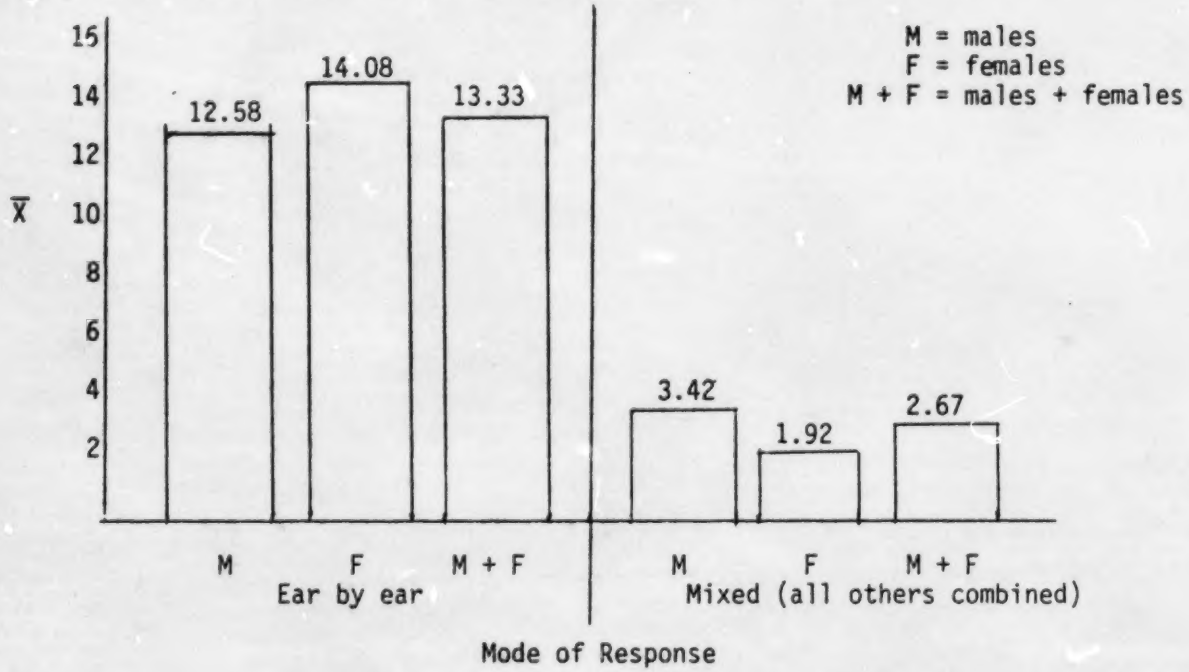

Figure 3. Mode of response, by sex, blocked versus unblocked, Experiment 2.

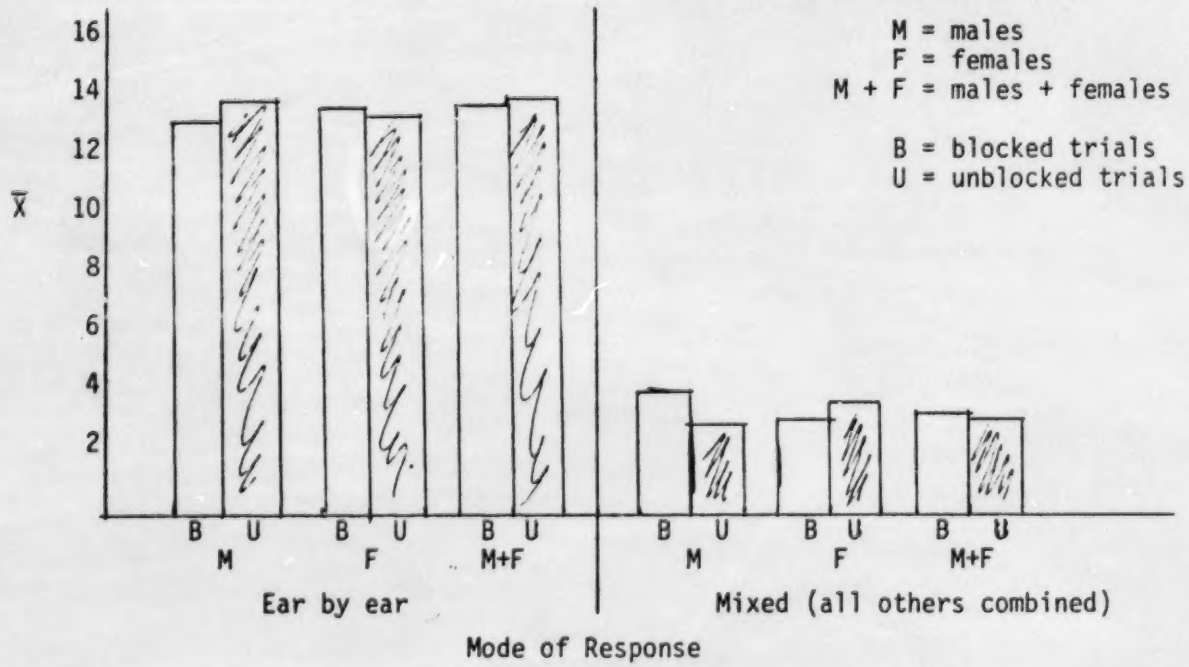

Figure 4. Mode of response, by Conditions, blocked versus unblocked, Experiment 2.

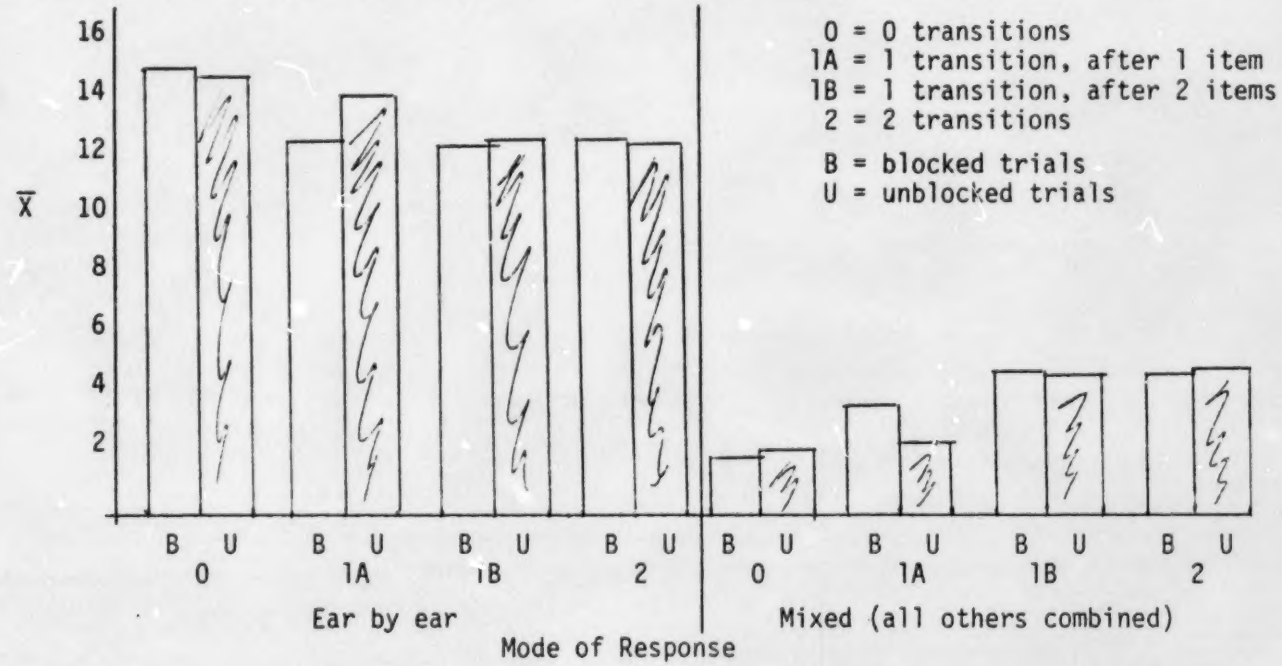

Figure 5. Mode of response, Condition CD (Experiment 1) versus 0 Transitions, blocked, (Experiment 2)

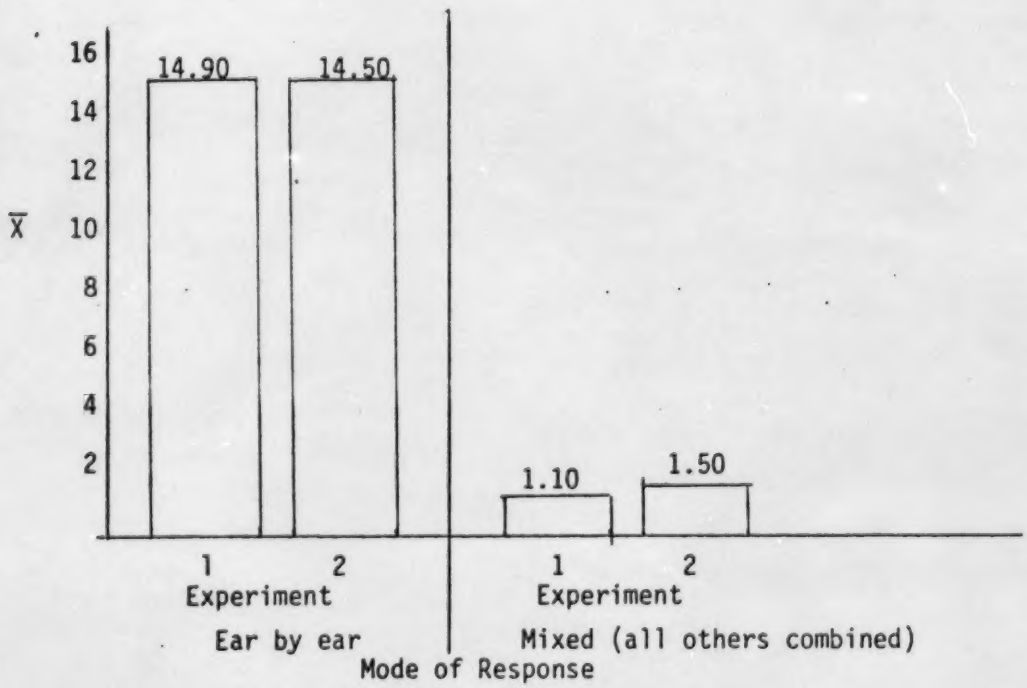

Figure 6. Number correct, by conditions and sex, Experiment 1.

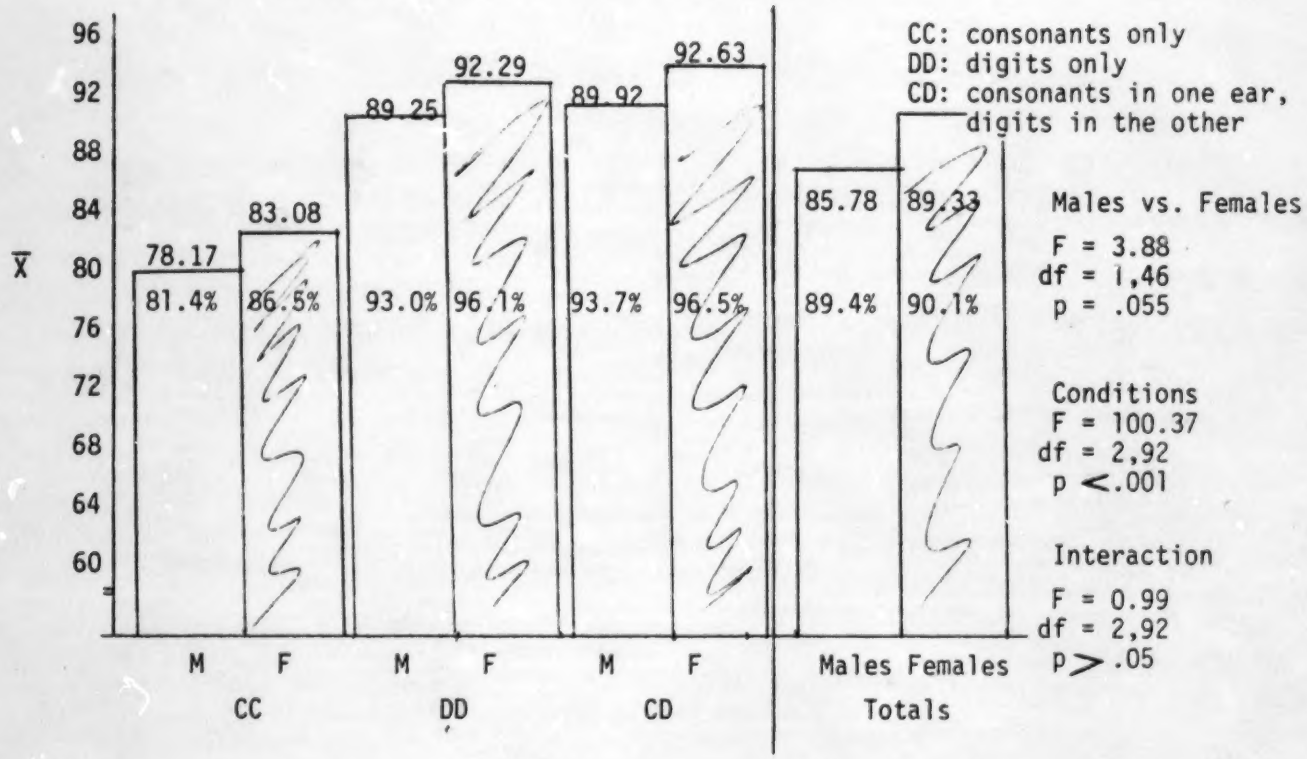

Figure 7. Number correct, by condition, right versus left ear, Experiment 1.

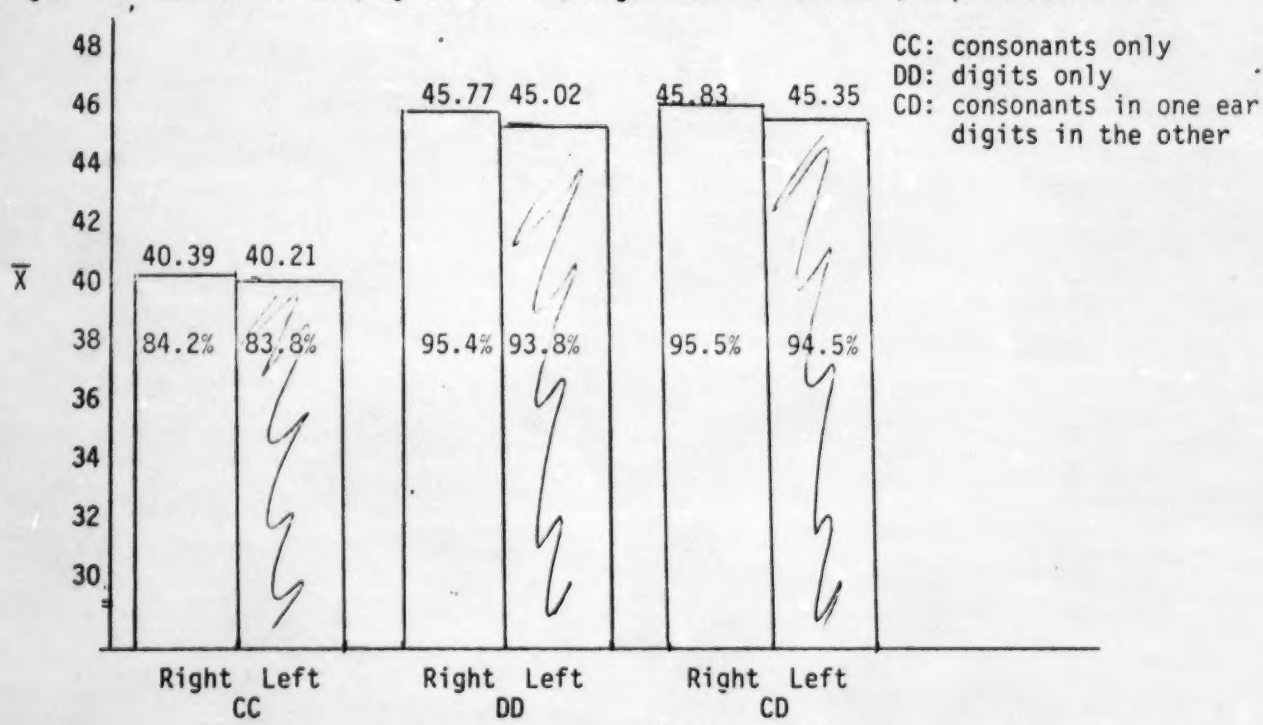

Figure 8. Number correct, consonants versus digits, for CD condition, Experiment 1.

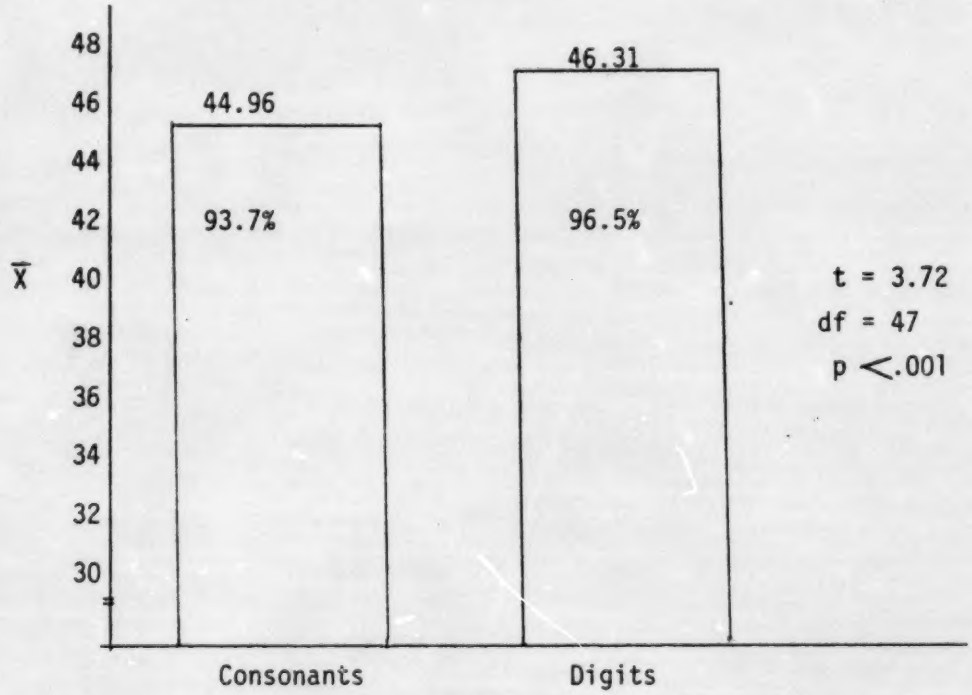

Figure 9. Number correct, consonants versus digits, by sex and blocked versus unblocked, Experiment 2.

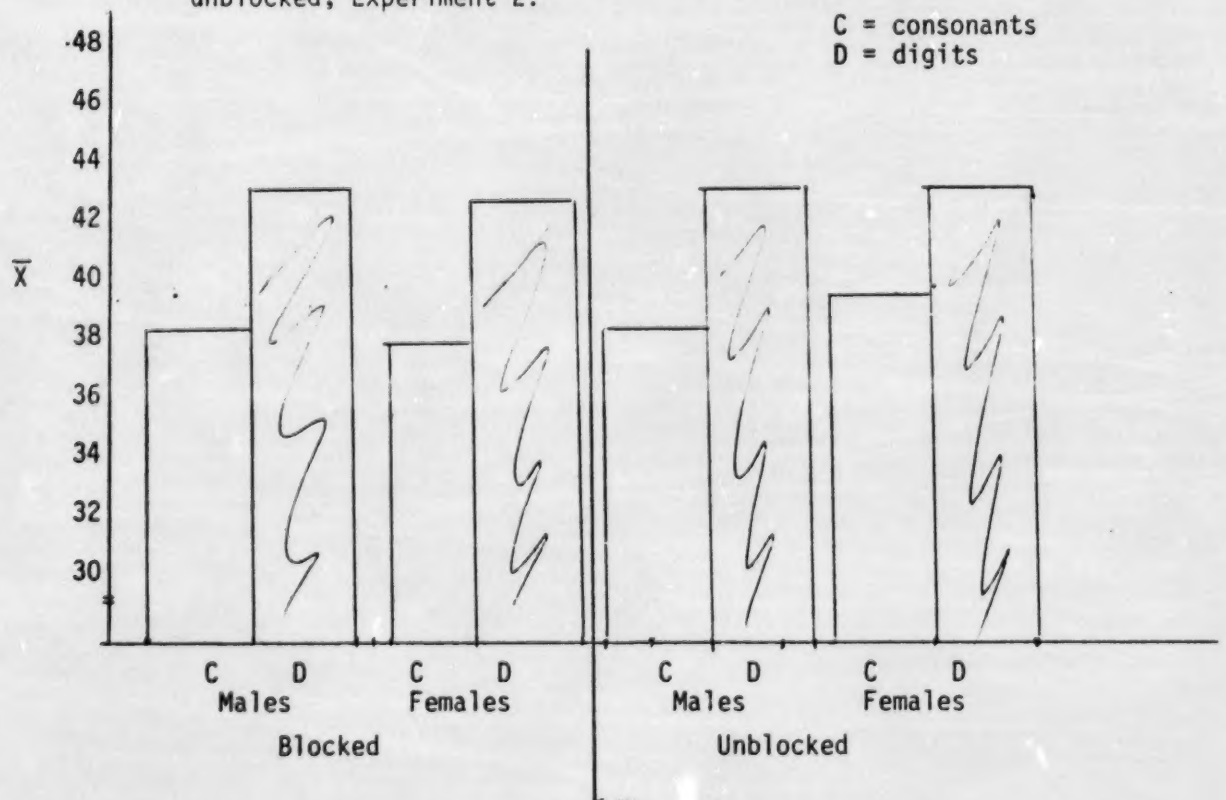

Figure 10. Number correct, right versus left ear, by sex and blocked versus unblocked, Experiment 2.

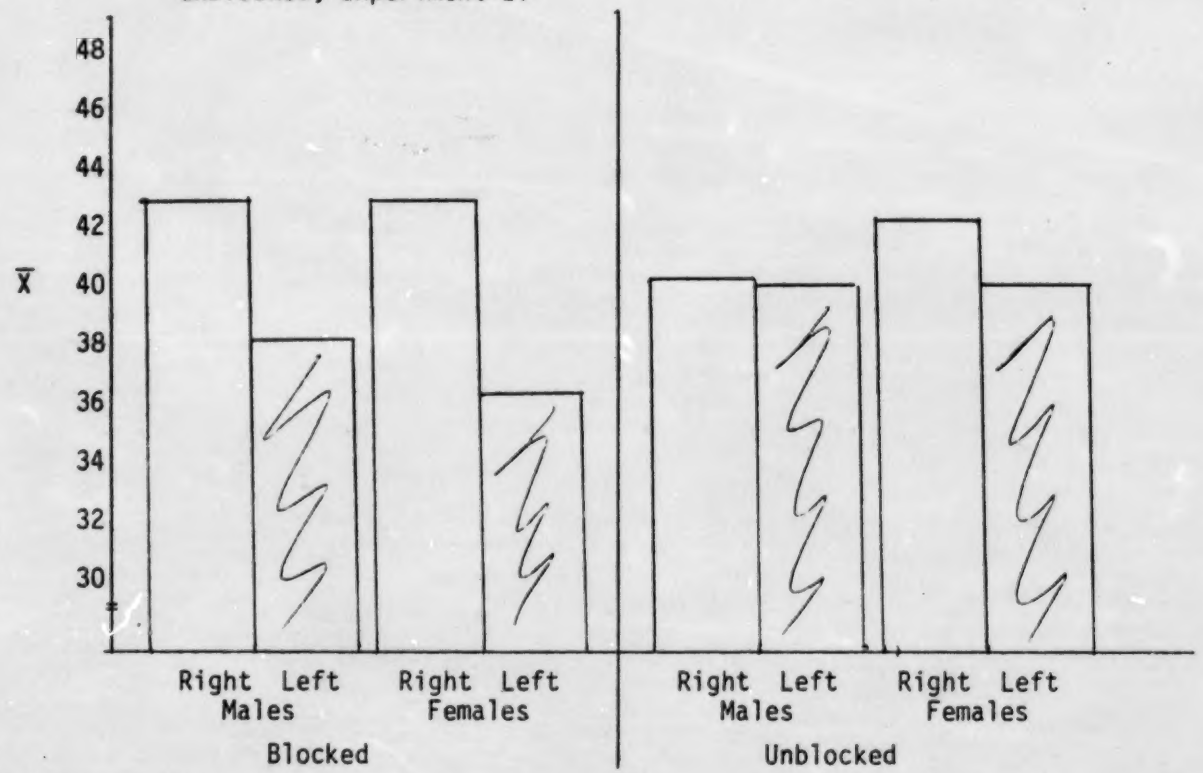

Figure 11. Number correct, by sex, blocked versus unblocked, Experiment 2.

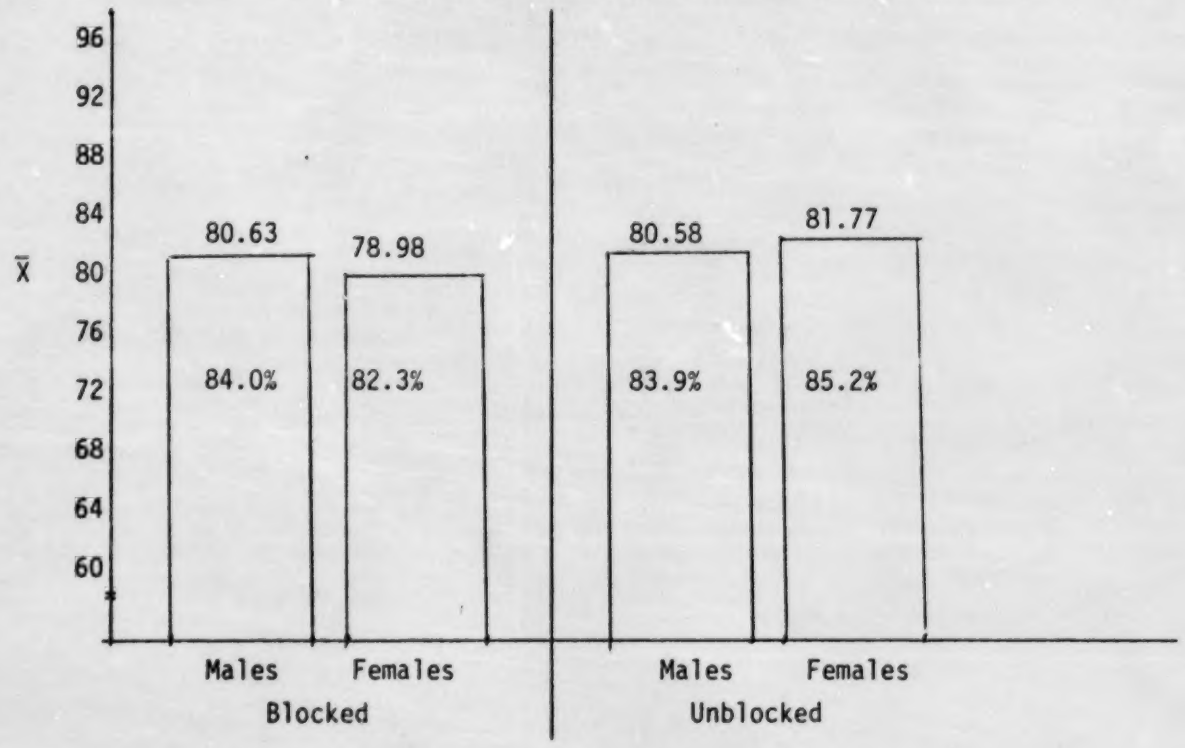

Figure 12. Number correct, by conditions, blocked versus unblocked, Experiment 2.

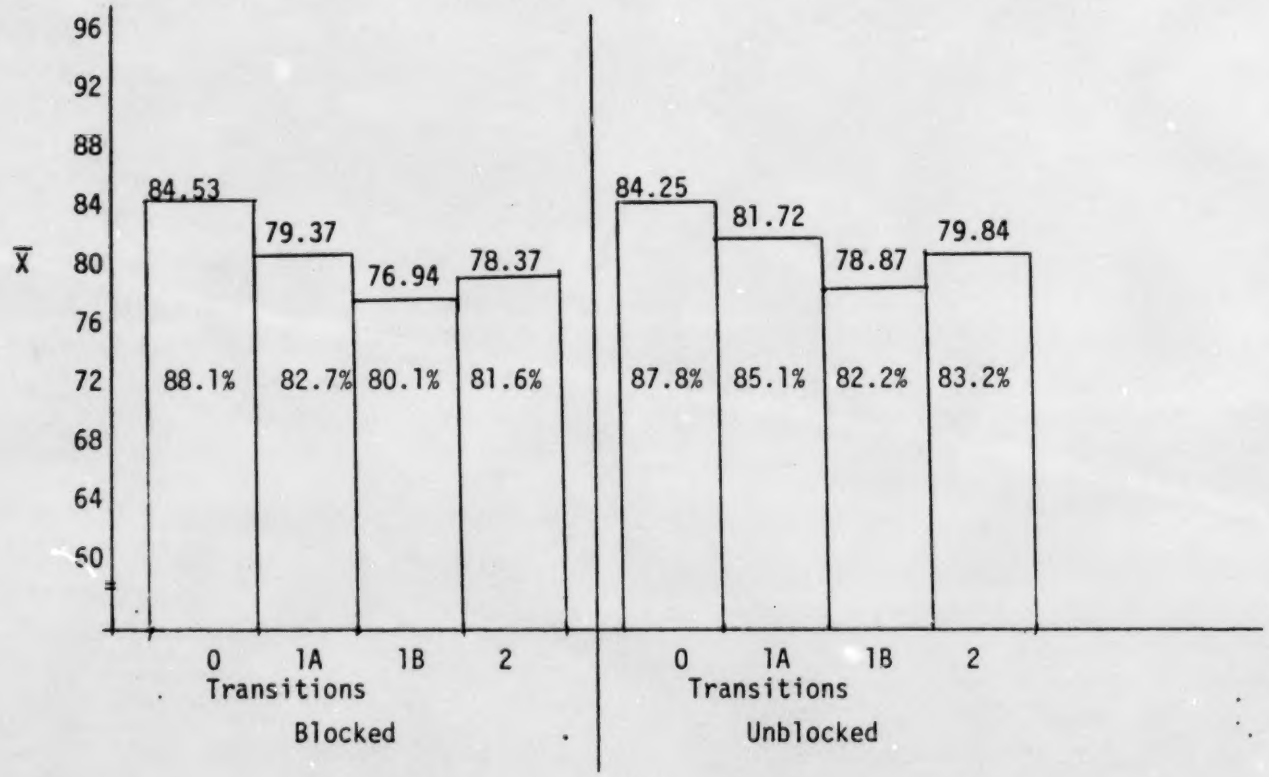

Figure 13. Number correct, consonants versus digits, Experiment 2.

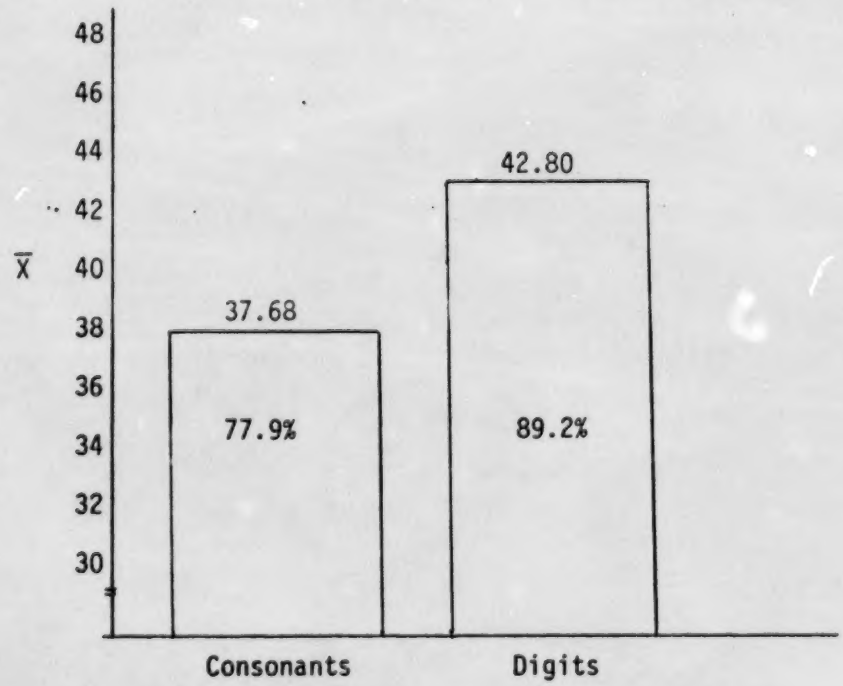

Figure 14. Number correct, consonants versus digits, for Experiment 1, Condition CD and Experiment 2, 0 Transitions, blocked.

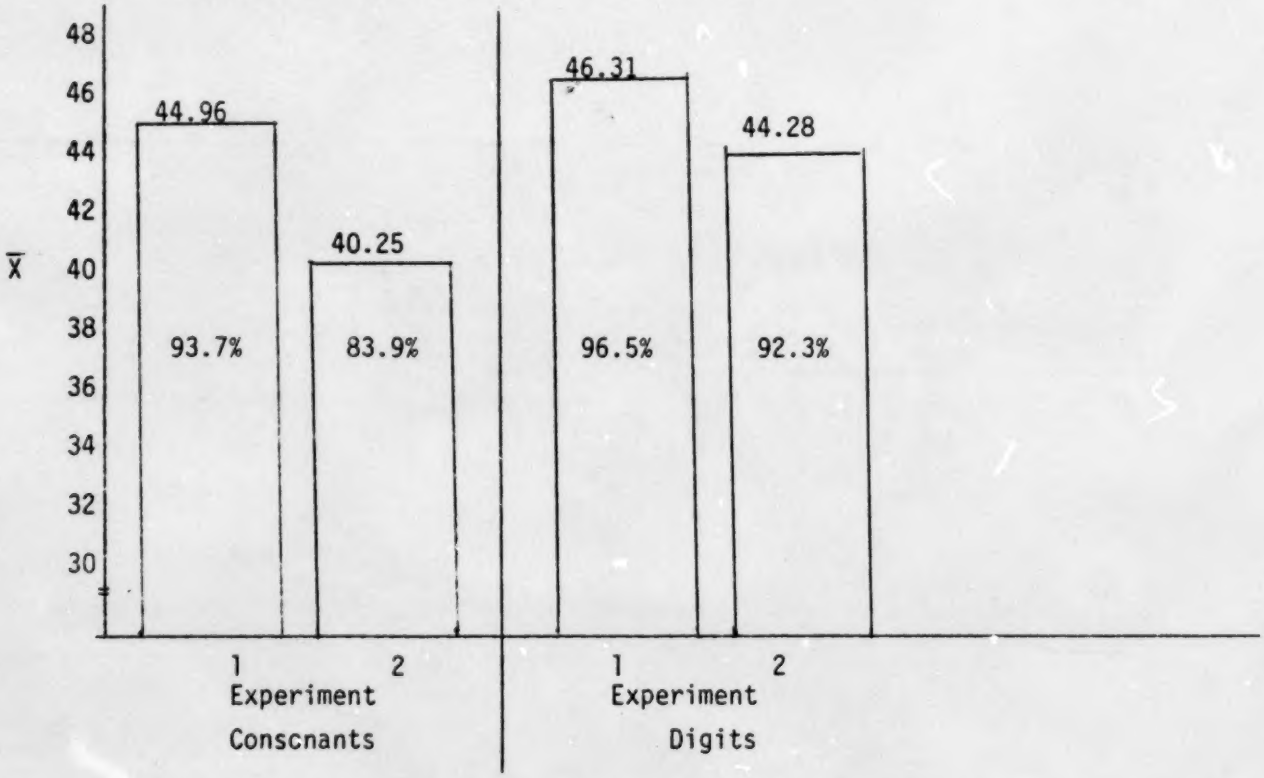

Figure 15. Number correct, right versus left ear, for Experiment 1, Condition CD and Experiment 2, 0 Transitions, blocked.